Bureau of Land Management, New Mexico State Office, November 2011

AIR RESOURCES TECHNICAL REPORT FOR OIL AND GAS DEVELOPMENT

NEW MEXICO, OKLAHOMA, TEXAS AND KANSAS

CONTENTS

AIR RESOURCES TECHNICAL REPORT FOR OIL AND GAS DEVELOPMENT IN NEW MEXICO, OKLAHOMA, TEXAS AND KANSAS

The purpose of this document is to summarize the technical information on air quality and climate change relative to all Environmental Assessment (EAs) for Application for Permit to Drill (APD). The intent of this document is to collect and present the data and information needed for air quality and climate change analysis pertaining to oil and gas development. This information can then be incorporated by reference into the site-specific National Environmental Policy Act (NEPA) documents as necessary. In addition, data is included in the appendices which can be incorporated into the site specific analysis included in the APD EAs.

While much of the information in this document is generic and applies to all areas of the United States some sections refer specifically to New Mexico. Because the Bureau of Land Management (BLM) manages extensive land holdings in New Mexico far more of its activities are centered there. The New Mexico State Office also has jurisdiction over development of federal mineral rights in Kansas, Texas, and Oklahoma. Wherever possible, information for those states is included. In addition separate sections have been added for each state outside New Mexico at the end of the report in order to insure completeness.

AIR RESOURCES

Air quality and climate are components of air resources which may be affected by BLM applications, activities, and resource management. Therefore, the BLM must consider and analyze the potential effects of BLM and BLM-authorized activities on air resources as part of the planning and decision making process. In particular, the activities surrounding oil and gas development are likely to have impacts related to air resources.

AIR QUALITY

The Clean Air Act, as amended, is the primary authority for regulation and protection of Air Quality in the United States. The Federal Land Policy and Management Act (FLPMA) also charges BLM with the responsibility to protect air and atmospheric values.

All areas of the United States not specifically classified as Class I by the Clean Air Act are considered to be Class II for air quality. Class I areas are afforded the highest level of protection by the Clean Air Act and include all international parks, national wilderness areas and national memorial parks >5,000 acres, and national parks >6,000 acres in size which were in existence on August 7, 1977. Moderate amounts of air quality degradation are allowed in Class II areas. While the Clean Air Act allows for designation of Class III areas where greater amounts of degradation would be allowed, no such areas have been successful in receiving such designation by the EPA. Air quality in a given area is determined by levels and chemistry of atmospheric pollutants, dispersion meteorology, and terrain.

CRITERIA AIR POLLUTANTS

The Environmental Protection Agency (EPA) has the primary responsibility for regulating atmospheric emissions, including six nationally regulated air pollutants defined in the Clean Air Act. These pollutants, referred to as "criteria pollutants," include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} & $PM_{2.5}$), sulfur dioxide (SO_2) and lead (Pb). The Clean Air Act charges EPA with establishing and periodically reviewing National Ambient Air Quality Standards (NAAQS) for each criteria pollutant. Table 1 shows the current NAAQS for each pollutant. Regulation and enforcement of the NAAQS has been delegated to the states by the EPA. New Mexico Ambient Air Quality Standards (NMAAQS) are also shown. Oklahoma, Kansas and Texas do not have state standards that differ from the NAAQS.

Table 1. National Ambient Air Quality Standards

	Primary Standards		Secondary Standards		New Mexico AAQS*
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**	
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour (1)	None		8.7ppm
	35 ppm (40 mg/m^3)	1-hour (1)			13.1 ppm
Lead	0.15 µg/m^3	Rolling 3-Month Average	Same as Primary		none
Nitrogen Dioxide	53 ppb	Annual (Arithmetic Average)	Same as Primary		50ppb
	100 ppb	1-hour (2)	None		100ppb (24-hour)
Particulate Matter (PM_{10})	150 µg/m^3	24-hour (3)	Same as Primary		**TSP 24 hour 150 µg/m^3

Particulate Matter ($PM_{2.5}$)	15.0 $\mu g/m^3$	Annual [4] (Arithmetic Average)	Same as Primary		**TSP 7 day 110 $\mu g/m^3$
	35 $\mu g/m^3$	24-hour [5]	Same as Primary		**TSP 30 day 90 $\mu g/m^3$
Ozone	0.075 ppm	8-hour [6]	Same as Primary		none
	0.12 ppm	1-hour [7]	Same as Primary		none
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Average)	0.5 ppm	3-hour [1]	0.02ppm
	0.14 ppm	24-hour [1]			0.10ppm
	75 ppb [8]	1-hour	None		none

Source: (EPA, 2011), *Source: 20.2.3 NMAC, **Total Suspended Particles

[1] Not to be exceeded more than once per year. [2] To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

[3] Not to be exceeded more than once per year on average over 3 years.

[4] To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 $\mu g/m^3$.

[5] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$ (effective December 17, 2006).

[6] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.

[7] (a) EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard ("anti-backsliding").
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1.

[8] (a) Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

EPA provides two types of data for each criteria air pollutant. One type of data is annual average concentrations measured at air monitors. Monitors measure concentrations of pollutant in the atmosphere and the results are presented in parts per million (ppm) or micrograms/cubic meter ($\mu g/m^3$). Monitors at some locations have been discontinued over time because pollutant levels at those locations are no longer of concern. Monitored criteria pollutant level data can be obtained from EPA's Air Explorer website (EPA, 2011a).

The second type of data is from the National Emissions Inventory (NEI), the most recent NEI data are from 2008 (EPA, 2011b). Emissions data is expressed in tons per year or total volume of pollutant released to the atmosphere. Emissions data is useful in comparing source categories to determine which industries or practices are contributing the most to the general level of pollution in an area.

The NEI data present the emissions of each criteria pollutant by county for major source sectors. These source sectors are defined in the 2002 NEI booklet (EPA, 2011c), but those mentioned in this report are also summarized here:

(1) Electricity generation is fuel combustion from electric utilities;

(2) Fossil fuel combustion is fuel combustion from industrial boilers, internal combustion engines, and commercial/institutional or residential use;

(3) Industrial processes include manufacturing of chemicals, metals, and electronics, storage and transfer operations, pulp and paper production, cement manufacturing, petroleum refineries, and oil and gas production;

(4) On-road vehicles includes both gasoline- and diesel-powered vehicles for on-road use;

(5) Non-road equipment includes gasoline- and diesel-powered equipment for non-road use, as well as planes, trains, and ships;

(6) Road dust includes dust from both paved and unpaved roads. Presentation of emissions data by source sector provides a better understanding of the activities that contribute to criteria pollutant emissions.

NEI data for New Mexico, Kansas, Oklahoma and Texas can be found in Appendix A.

OZONE (O_3)

Ground level ozone is not emitted directly into the air, but is created by chemical reactions between NO_x (oxides of nitrogen) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC (EPA, 2010a). VOCs refer to organic chemical compounds which participate in atmospheric photochemical reactions to form secondary pollutants such as ozone which can affect the environment and human health. VOCs can be a product of human activity, but they are also naturally occurring as a byproduct of vegetation. While ozone and NO_2 are criteria air pollutants, VOCs are not.

VOCs are emitted during well drilling and operations as exhaust from internal combustion engines. VOCs are also a component of natural gas, and during a conventional well completion, natural gas may be temporarily vented, resulting in the release of VOCs. Natural gas actuated valves are commonly utilized on gas well production equipment. During the valve actuation process, some natural gas is released into the atmosphere (fugitive gas). Recently, many producers have initiated programs to replace "high bleed" valves with "low bleed" valves to reduce fugitive gas emissions. VOCs may also be released because of leaking tanks and pipelines but because this cannot be predicted, these emissions are not included in the estimates. NOx emissions are discussed below under NO_2.

An emissions inventory conducted for the Carlsbad Field Office for 2007 and including Chaves, Lea, and Eddy counties (AES, 2011) shows that VOC emissions from biogenic (natural) sources are far greater than those from anthropogenic (human) sources and account for 91% of VOCs inventoried. Point source emissions (which might include such industrial sources as power plants, gas plants and oil refineries) account for 40% of anthropogenic VOC emissions in the area, solvent use accounts for 15%, and fire (including wildland, structure, and open burning) accounts for 8%. Oil and gas area sources produce only 1.4% of VOCs in the area while pipeline transport of oil and gas accounts for 1.7%.

In 2005, the top two sources of VOC emissions in the Farmington Field Office counties were on-road vehicles (6,569 tons; 30.1%), and industrial processes (5,294 tons; 24.3%).

The NAAQS for ozone is the three-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration, which for simplicity is sometimes referred to as the "design value." Between 1997 and 2008, the NAAQS for ozone was 0.084 ppm. To attain this standard, the design value for ozone levels detected by New Mexico Air Quality Bureau (NMAQB) air monitors could not exceed this level. In 2008 the NAAQS for ozone was lowered to 0.075 ppm.

In 2009 a photochemical modeling project was completed for the Four Corners Air Quality Task Force (FCAQTF). Potential ozone impacts and the usefulness of certain mitigation measures were analyzed (Environ, 2009). This modeling showed that the FFO would continue to meet the current ozone standard in 2018. The analysis showed that mitigation would be required for both power plants and oil and gas sources in order to achieve measurable reductions in ozone concentrations. Even then, the best achievable ozone reductions from the modeled mitigation scenarios were on the order of 5 ppb (Environ, 2009).

The modeling project done for FCAQTF also used source apportionment modeling, which indicated that, in general, transport from outside the region and naturally occurring VOCs from vegetation were large contributors to baseline ozone levels. However it was also shown that on high ozone days in the summer, oil and gas sources and electricity generation units (EGUs) both contributed significantly to the total modeled ozone value.

Ozone modeling for the Carlsbad area is currently in progress.

NITROGEN DIOXIDE (NO_2)

NO_2 is both a criteria pollutant and an indicator for the NO_x family of nitrogen oxide compounds that are ground-level ozone pre-cursors. The nitrogen oxide family of compounds includes nitric oxide (NO), nitrogen dioxide (NO_2), nitrous acid ($HN0_2$), and nitric acid (HNO_3). The primary sources of NO_x are internal combustion engines and thermal power electric generation units (EPA, 2010b). The excess air required for complete combustion of fuels in these processes introduces atmospheric nitrogen into the combustion reactions at high temperatures and produces nitrogen oxides. NO_2 has been shown to cause adverse respiratory impacts in both healthy people and those with asthma, and is also an important contributor to the formation of ground-level ozone (EPA, 2010b, d).

NO_x emissions in the Carlsbad area are largely anthropogenic (88%). Of the total human caused NOx emissions, industrial point sources account for 84%, on-road mobile sources account for 7%, oil and gas areas sources account for 5%, non-road mobile sources account for 2%, and residential heating with natural gas and propane account for 1%. (AES, 2011).

The top three sources of NO_x emissions in the FFO area in 2005 were electricity generation (72,361 tons; 70.7%), fossil fuel combustion (10,511 tons; 10.3%); and on-road vehicles (10,117 tons; 9.9%; EPA, 2010d).

CARBON MONOXIDE (CO)

Carbon monoxide is produced from the incomplete burning of carbon-containing compounds such as fossil fuels; it forms when there is not enough oxygen to produce carbon dioxide (CO_2). Nationally, two thirds of CO emissions come from transportation sources. CO is associated with negative health effects to human cardiovascular, central nervous, and respiratory systems (EPA, 2010d). There are currently no non- attainment areas for CO in the United States.

The 2007 emissions inventory for Chaves, Eddy, and Lea Counties shows that anthropogenic sources account for 65% of CO emissions and biogenic sources 35%. Of the anthropogenic emissions 47% are from on road mobile sources, 24% from industrial point sources, 14% from non-road mobile sources, 9% from fire, and 2% each from oil and gas area sources and waste disposal burning (AES, 2011).

The two main sources of CO emissions in the FFO area in 2005 were on-road vehicles (82,964 tons; 65.2%) and other internal combustion engine equipment (15,889 tons; 12.5%; EPA, 2010d).

PARTICULATE MATTER (PM)

Particulate matter, also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. PM is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles (EPA, 2010d). PM is measured and regulated according to particle size. PM_{10} refers to all particles with a diameter of 10 microns or less. $PM_{2.5}$ is made up of particles with diameters of 2.5 microns or less. Smaller particles are associated with more negative health effects, including respiratory and cardiovascular problems because they can become more deeply embedded in the lungs (EPA, 2010d).

The 2007 emissions inventory for Chaves, Eddy, and Lea Counties shows that the bulk of emission for both PM10 and PM2.5 are from dust from unpaved roads (88 and 65% respectively). For PM10 the next three highest categories are point sources at 2.8%, tilling and harvesting 2.6% and paved roads 2.4%. Oil and gas area sources account for only 0.1% of PM10 emissions. For PM2.5 the next three highest categories are point sources at 17%, fire at 4.3% and tilling and harvesting at 2.8%. Oil and gas area sources account for 0.8% of PM2.5 emissions in this area.

In the FFO area, most PM is from road dust ($PM_{2.5}$: 19,894 tons, 69.1%; PM_{10}: 199,905 tons, 90.8%) and electricity generation ($PM_{2.5}$: 5,516 tons, 19.2%; PM_{10}: 8,142 tons, 3.7%; EPA, 2010d).

SULFUR DIOXIDE (SO2)

Sulfur dioxide (SO_2) is one of a group of highly reactive gases known as “oxides of sulfur,” commonly referred to as SO_x. The largest sources of SO_2 emissions nationwide are from fossil fuel combustion at power plants (73%) and other industrial facilities (20%). Smaller sources of SO_2 emissions include industrial processes, such as extracting metal from ore, and the burning of high sulfur-containing fuels by locomotives, large ships, and non-road equipment. SO_2 is linked with a number of adverse effects on the respiratory system (EPA, 2010d).

The Carlsbad area 2007 emissions inventory does not differentiate SO_2 from SO_x but it can be assumed that the percentage of emissions by category is similar. In this region oil and gas area sources account for 74% of all SO_x emissions with most of the remainder, 25% accounted for by industrial point sources.

In the FFO area in 2005, nearly all SO_2 emissions come from electricity generation (30,418 tons; 95.5%; EPA, 2010d).

LEAD

With the elimination of lead from gasoline and regulation of industrial sources, levels of lead in the atmosphere decreased 94% nationwide between 1980 and 1999. While still regulated as a criteria pollutant, the only major sources of lead pollution are lead smelters and leaded aviation gasoline (EPA, 2010e). All areas of the Unites States are in attainment of the National Ambient Air Quality Standard for lead.

HAZARDOUS AIR POLLUTANTS

The U.S. Congress amended the Federal Clean Air Act in 1990 to address a large number of air pollutants that are known to cause or may reasonably be anticipated to cause adverse effects to human health or adverse environmental effects. Congress initially identified 188 specific pollutants and chemical groups as hazardous air pollutants (HAPs) and has modified the list over time.

The Clean Air Act governs the federal control program for hazardous air pollutants. National emissions standards for hazardous air pollutants (NESHAPs) are issued by EPA to limit the release of specified HAPs from specific industrial sectors. These standards are technology based, meaning that they represent the maximum available control technology that is economically feasible for an industrial sector.

The CAA defines a major source for HAPs to be one emitting 10 tons per year of any single HAP or 25 tons per year of any combination of HAPs. Under state regulations a construction or operating permit may be required for any major source (20.2.70 New Mexico Administrative Code (NMAC) and 20.2.73 NMAC) though some exceptions apply. Within its definition of a major source in the above referenced regulations the state of New Mexico includes the following language:

> *…hazardous emissions from any oil or gas exploration or production well (with its associated equipment) and hazardous emissions from any pipeline compressor or pump station shall not be aggregated with hazardous emissions from other similar units, whether or not such units are in a contiguous area or under common control, to determine whether such units or stations are major sources…*

In other words, in determining a major source, oil and gas exploration and production wells must be considered one at a time.

NESHAPs for Oil and Natural Gas Production and Natural Gas Transmission and Storage were published by EPA on June 17, 1999. These NESHAPs were directed toward major sources and intended to control benzene, toluene, ethyl benzene, mixed xylenes and n-hexane. An additional NESHAP for Oil and Natural Gas Production Facilities directed toward area sources was published on January 3, 2007 and specifically addresses benzene emissions from triethylene glycol dehydrations units. The EPA is currently reviewing NESHAPs for the oil and gas industry (Fed. Reg. 75(133): 39934-39935, July 13, 2010), and may soon revise the current regulations.

The state of New Mexico incorporates federal NESHAPs for pollutants through annual updates to 20.2.78 NMAC, which adopts 40 CFR Part 61, and federal NESHAPs for source categories through annual updates to 20.2.82 NMAC, which adopts 40 CFR Part 63.

In March 2011 EPA published the fourth in a series of National Scale Air Toxics Assessments (NATA). Based on 2005 data including the National Emissions Inventory, the NATA is intended to be a tool to help focus emissions reduction strategies (EPA, 2011h). Computer models are used to develop estimates of risk of cancer or other health impacts. NATA presents risk hazard indexes for cancer, neurological and respiratory problems for each county and census tract. Because techniques have changed over the years each NATA is not comparable to those previously issued. EPA also cautions that because data availability varies from state to state the results are not necessarily comparable from one geographic area to another. NATA data for New Mexico, Kansas, Oklahoma, and Texas can be found in Appendix B.

HYDROGEN SULFIDE (H_2S)

H_2S is a colorless flammable gas with a rotten egg smell which is a naturally occurring byproduct of oil and gas development in some areas, including the New Mexico portion of the Permian Basin. Hydrogen sulfide is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Effects may range from eye, nose and throat irritation to dizziness, headaches and nausea. High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death. Effects can occur within a few breaths, and possibly a single breath.

H_2S was originally included in the list of Toxic Air Pollutants defined by Congress in the 1990 amendments to the Clean Air Act. It was later determined that H_2S was included through a clerical error and it was removed by Congress from the list. H_2S was addressed under the accidental release provisions of the Clean Air Act. Congress also tasked EPA with assessing the hazards to public health and the environment from H_2S emissions associated with oil and gas extraction. That report was published in October 1993 (EPA, 1993).

EPA found that while there was a potential for human and environmental exposure from routine emissions of H_2S from oil and gas wells, there was insufficient evidence to suggest that these exposures were a significant threat. H_2S is present in some production zones in the CFO. Flaring is used to reduce the H_2S emissions and the CFO has developed a series of standard conditions of approval for high H_2S areas in order to mitigate the risk of H_2S exposure.

While there are no national ambient air quality standards for H_2S, a number of states, especially those with significant oil and gas production, have set standards at the state level. Table 2 summarizes these standards for states under BLM New Mexico State Office jurisdiction.

Table 2. State Ambient Air Quality Standards for H_2S

State	Standard	Averaging time	Remarks
Kansas	None		
Oklahoma	200 ppb* (0.2 ppm)	24 hr	
New Mexico	0.010 ppm** (10 ppb)	1 hr	Statewide except Pecos-Permian Basin Intrastate Air Quality Control Region***
	0.100 ppm (100 ppb)	½ hr	Pecos-Permian Basin Intrastate Air Quality Control Region
	0.030ppm (30 ppb)	½ hr	Within municipal boundaries and within five miles of municipalities with population >20,000 in Pecos-Permian Basin AQ Control Region
Texas	0.08ppm (80 ppb)	½ hr	If downwind concentration affects a property used for residential business or commercial purposes
	0.12 ppm (120 ppb)	½ hr	If downwind concentration affects only property not normally occupied by people

Source: (Skrtic, 2006) *parts per billion **parts per million *** The Pecos-Permian Basin Intrastate Air Quality Control Region is composed of Quay, Curry, De Baca, Roosevelt, Chaves, Lea, and Eddy Counties in New Mexico.

The New Mexico Environment Department (NMED) has no routine monitors for H_2S. However, a one-time study done in 2002 (Skrtic, 2006) sheds some light on the levels which can be expected near oil and gas facilities. These readings are averaged over 3 minute periods so are not comparable with the standard which has longer averaging periods. The monitoring data is presented in Table 3.

Table 3: Summary of Monitoring Data from New Mexico Study

Facility type	H_2S concentration measured at monitoring site (ppb)	
	Range	Average
Indian Basin Hilltop, no facility	5 – 8	7
Indian Basin Compressor Station	3 – 9	6
Indian Basin Active Well Drilling Site	7 – 190	114
Indian Basin Flaring, Production, and Tank Storage Site	4 – 1,200	203
Marathon Indian Basin Refining and Tank Storage Site	2 – 370	16
Carlsbad City Limits, near 8 to 10 wells and tank storage sites	5 –7	6
Carlsbad City Limits, Tracy-A	5 – 8	7
Compressor station, dehydrators – LocationA	4 –5	4
Compressor station, dehydrators – Location B	2 – 15,000	1372
Huber Flare/Dehydrating Facility	4 – 12	77
Snyder Oil Well Field	2 – 5	4
Empire Abo Gas Processing Plant	1 – 1,600	300
Navajo Oil Refinery	3 – 14	7 - 8

Source: Skrtic, 2006

In Oklahoma routine monitoring downwind of two refineries in Tulsa showed H_2S levels that were within state standards but above normal background levels. In Texas, which has 12 routine montitors, H_2S levels generally ranged from 0.1 to 5 ppb. One monitor at a compressor station, however, showed frequent levels in excess of the state standard of 0.8 ppm (Skrtic, 2006).

In a recent study by the Fish and Wildlife Service (Lusk and Kraft, 2010) H_2S was monitored in southeast New Mexico to determine potential impacts to wildlife. Peak H_2S measurements near oil and gas facilities were generally found to be below 6 ppm but occasional peaks at 33 ppm and 27 ppm were noted near Loco Hills. Away from oil and gas operations readings were less than 1 ppm. A significantly lower number of birds was found at sites with higher H_2S levels compared with sites undisturbed by oil and gas development where H_2S levels were lower.

AIR QUALITY RELATED VALUES (AQRVS)

AQRVs have been defined as resources that may be adversely affected by a change in air quality. Such resources may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreation resource identified for a particular area. The Federal Land Managers' Air Quality Related Values Workgroup (FLAG) issued a revised Phase 1 report in 2010 (USFS et. al., 2010). This report was developed as a tool to provide consistent approaches to the analysis of the effects of air pollution on AQRVs. The FLAG report focuses on three areas of potential impact: visibility, aquatic and terrestrial effects of wet and dry pollutant deposition, and terrestrial effects of ozone. This report is therefore structured to address these same three areas of potential impact.

VISIBILITY

Visibility is of greatest concern in Class I areas which are afforded the highest level of air quality protection by the Clean Air Act. Visibility impairment is a result of Regional Haze which is caused by the accumulation of pollutants from multiple sources in a region. Emissions from industrial and natural sources may undergo chemical changes in the atmosphere to form particles of a size which scatter or absorb light and result in reductions in visibility.

In 1985 the EPA initiated a network of monitoring stations to measure impacts to visibility in Class 1 Wilderness Areas. These monitors are known as the Interagency Monitoring for the Protection of Visual Environments (IMPROVE) monitors and exist in some but not all Class I wilderness areas. Table 4 shows the Class I areas in the BLM New Mexico State Office area of responsibility and whether they have an IMPROVE monitor and, if not, which monitor is considered representative for that area. There are no Class I areas in Kansas.

Table 4. Class I areas and IMPROVE monitors

State	Class I Area	Agency	IMPROVE
New Mexico	Bandelier	National Park Service	Yes
	Bosque del Apache	Fish and Wildlife	Yes
	Carlsbad Caverns	National Park Service	Guadalupe Mtns
	Gila	Forest Service	Yes
	Pecos	Forest Service	Wheeler Peak
	Salt Creek	Fish and Wildlife	Yes
	San Pedro Parks	Forest Service	Yes
	Wheeler Peak	Forest Service	Yes
	White Mountain	Forest Service	Yes
Texas	Big Bend	National Park Service	Yes
	Guadalupe Mtns	National Park Service	Yes
Oklahoma	Wichita Mountains	Fish and Wildlife	Yes

Figure 1 shows visibility extinction trends for each of the IMPROVE monitors in the BLM New Mexico State Office area of responsibility. The top line on each graph is for the 20% worst days and the bottom line is for the 20% best days. Note that peaks such as that seen for Bandelier National Monument in 2000 may be accounted for by the occurrence of large wildfires. A downward sloping line means less reduction of visibility and therefore an improvement. In most cases visibility trends have been flat or improving. Implementation of Best Available Retrofit Technology (BART) strategies as required under the Regional Haze Rule over the next few years should result in further improvements.

A qualitative discussion of visibility impacts from oil and gas development in the Farmington Resource Management Plan (RMP) concludes that for the scenario modeled, which projected greater development than has occurred, there could potentially be significant impacts to visibility at Mesa Verde National Park, a Class I area in southwest Colorado. Occasional impacts to San Pedro Parks (northern New Mexico) and Weminuche (southern Colorado) Wilderness areas were also thought possible. However, visibility trends shown below for San Pedro Parks, Mesa Verde, and Weminuche indicate that visibility on the best days has been flat to improving and visibility on worst days has shown little change over the period of record.

Figure 1. Visibility Extinction in Class I areas

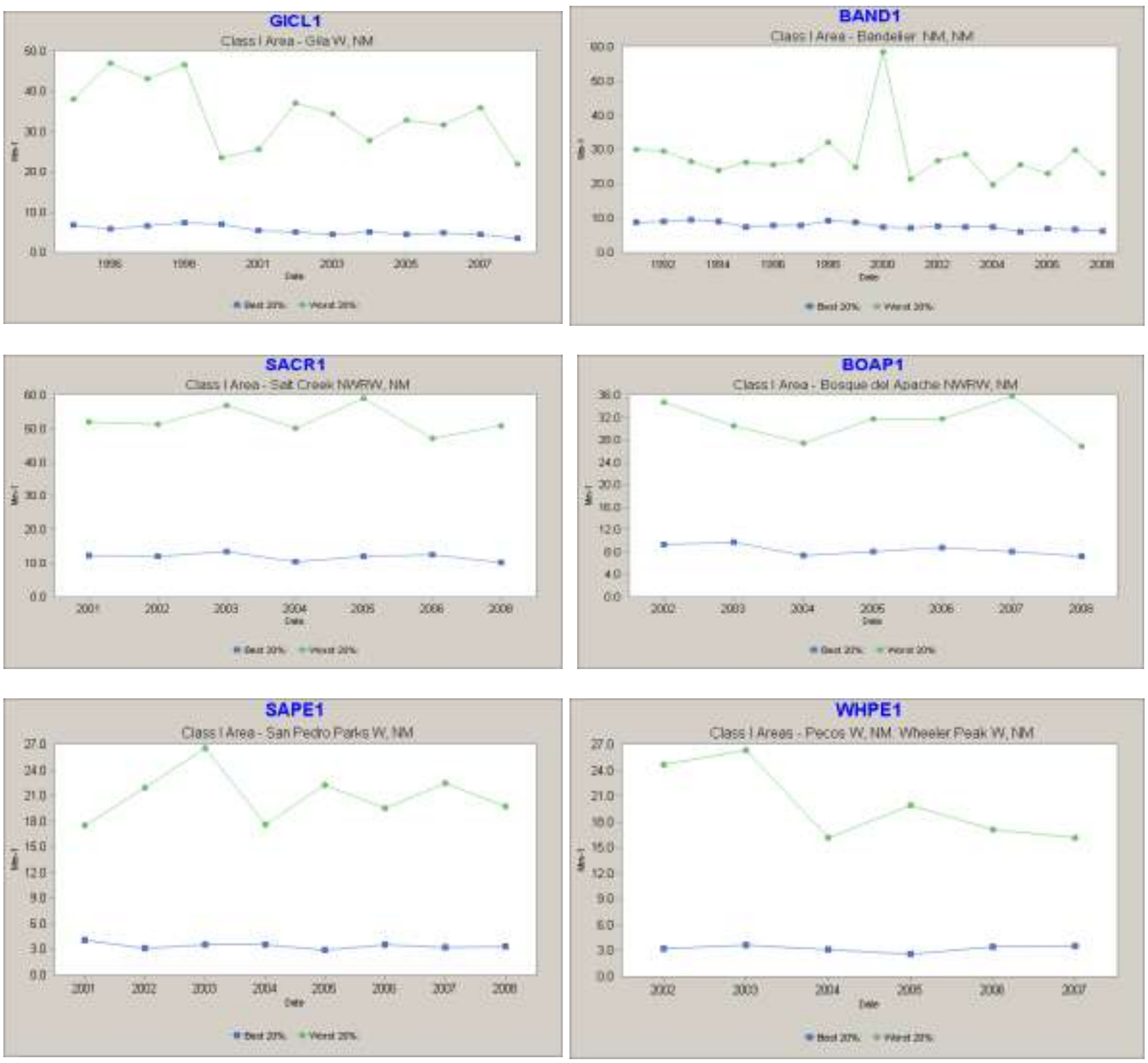
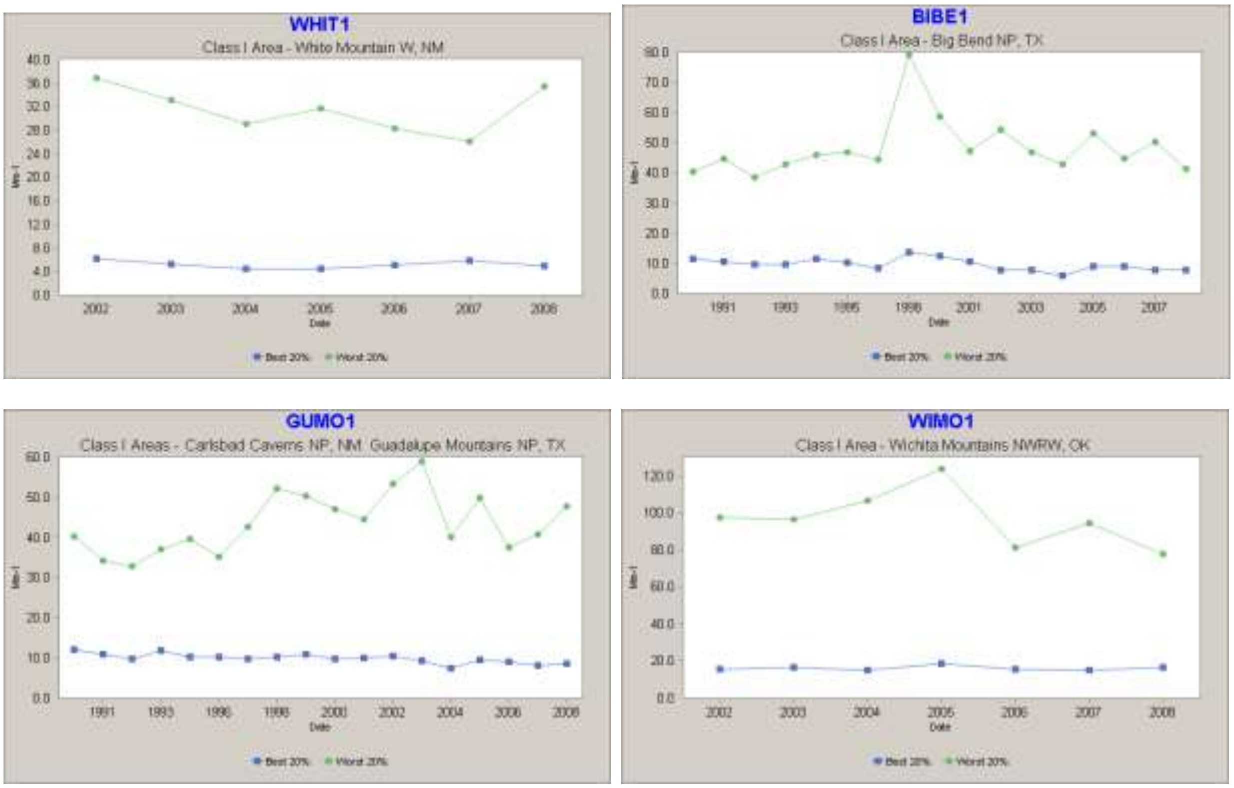


Figure 1. Visibility Extinction in Class I areas (continued)

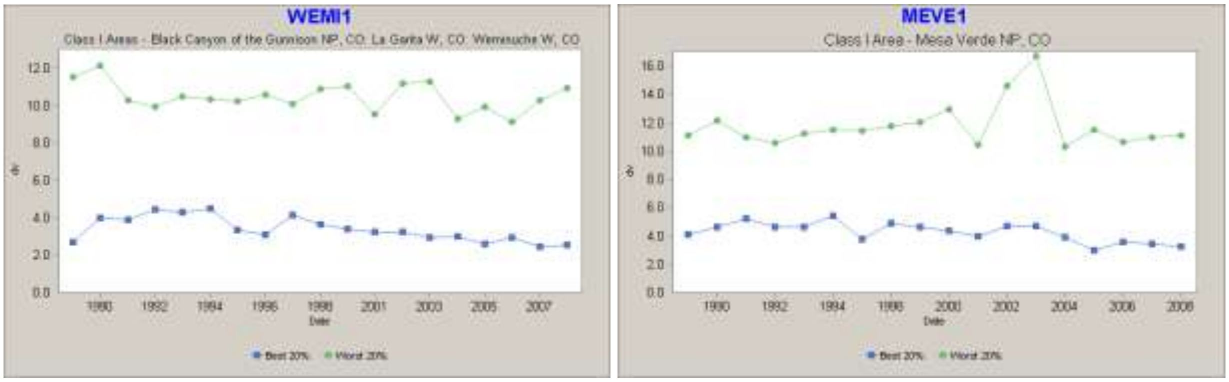


Source: CSU, 2011

Trend lines for other Class I areas in the region are similar showing no obvious indication of significant impacts from oil and gas development. While visibility on worst days at Guadalupe Mountains National Park may have diminished, a careful analysis of fire activity in the area would be necessary in order to draw conclusions about the cause of some peaks in recent years (CSU, 2011).

A recent study of Air Pollutant Emissions and Cumulative Air Impacts done for the Carlsbad Field Office indicates that pollutants contributing to reductions in visibility are largely coming from outside the region (AES, 2011).

Figure 2. Visibility trends at Class I areas downstream of Farmington Field Office area



Source: (CSU, 2011)

WET AND DRY POLLUTANT DEPOSITION

Deposition of pollutants through precipitation can result in acidification of water and soil resources in areas far removed from the source of the pollution as well as causing harm to terrestrial and aquatic species. Some pollutants can also damage vegetation through direct or dry deposition. In general, the soils in New Mexico have a high acid neutralizing capacity and surface water is scarce, resulting in minimal impacts in this area. Also, the Acid Rain Program has resulted in greatly reduced levels of the most damaging pollutants. There are currently four wet deposition monitors in New Mexico including Gila Cliff Dwellings, Mayhill, Bandelier National Monument, and Capulin Volcano National Monument. In addition monitors near the border at Mesa Verde and Guadalupe Mountains National Parks may shed some light on conditions in New Mexico. Data can be accessed through the National Atmospheric Deposition Network (NADP) http://nadp.sws.uiuc.edu/NTN/ntnData.aspx. Wet deposition data is also available for monitoring sites in Kansas, Oklahoma, and Texas at this site.

The EPA has operated the Clean Air Status and Trends Network (CASTNET) since 1991. There are currently no CASTNET observation sites in New Mexico but there are three in Texas and one each in Oklahoma and Kansas. National maps of pollutant concentrations can be found at http://java.epa.gov/castnet/maps.do?mapType=MAPCONC. These maps show that New Mexico and most of the western United States have much lower concentrations of all monitored pollutants than the eastern states and southern California. Nitrates are elevated in Kansas and Oklahoma but this is likely associated with agricultural activities rather than oil and gas development. The maps also show that the trend over the past 20 years has been for decreases in all pollutants in most areas of the country. As an example Figure 3 shows particulate nitrate and sulfate levels for 1990 and 2009. Maps of wet deposition data from NADP monitors are also available at this site (EPA, 2011f). Downward trends in pollutant levels are discussed in depth in the CASTNET annual report (MACTEC, 2011).

Figure 3a. Particulate Nitrate 1990(left) and 2009(right)

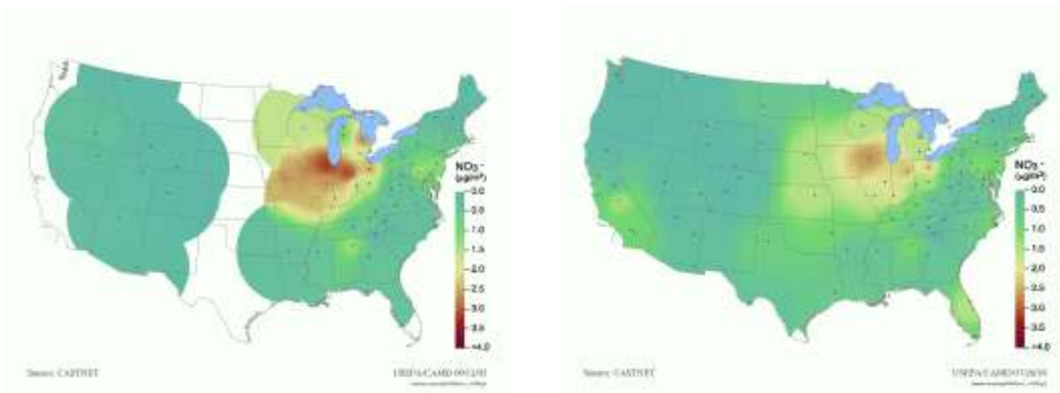
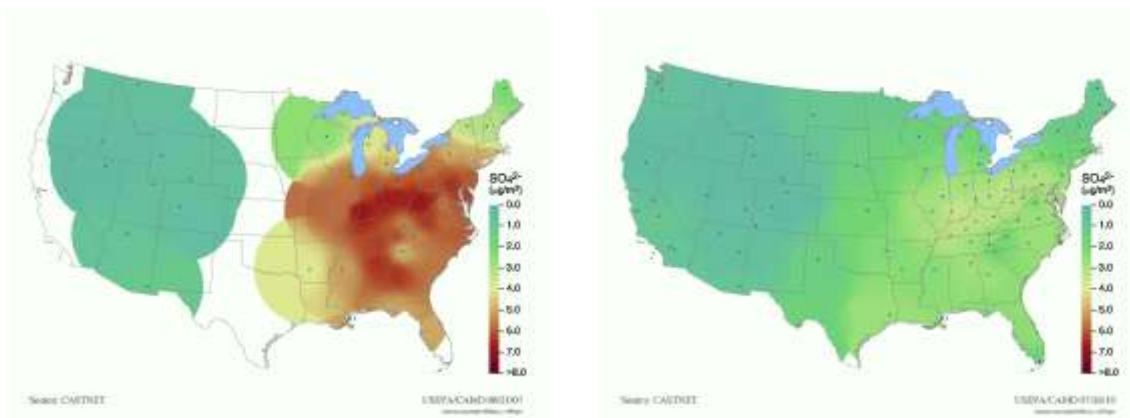


Figure 3b. Particulate Sulfate 1990(left) and 2009(right)



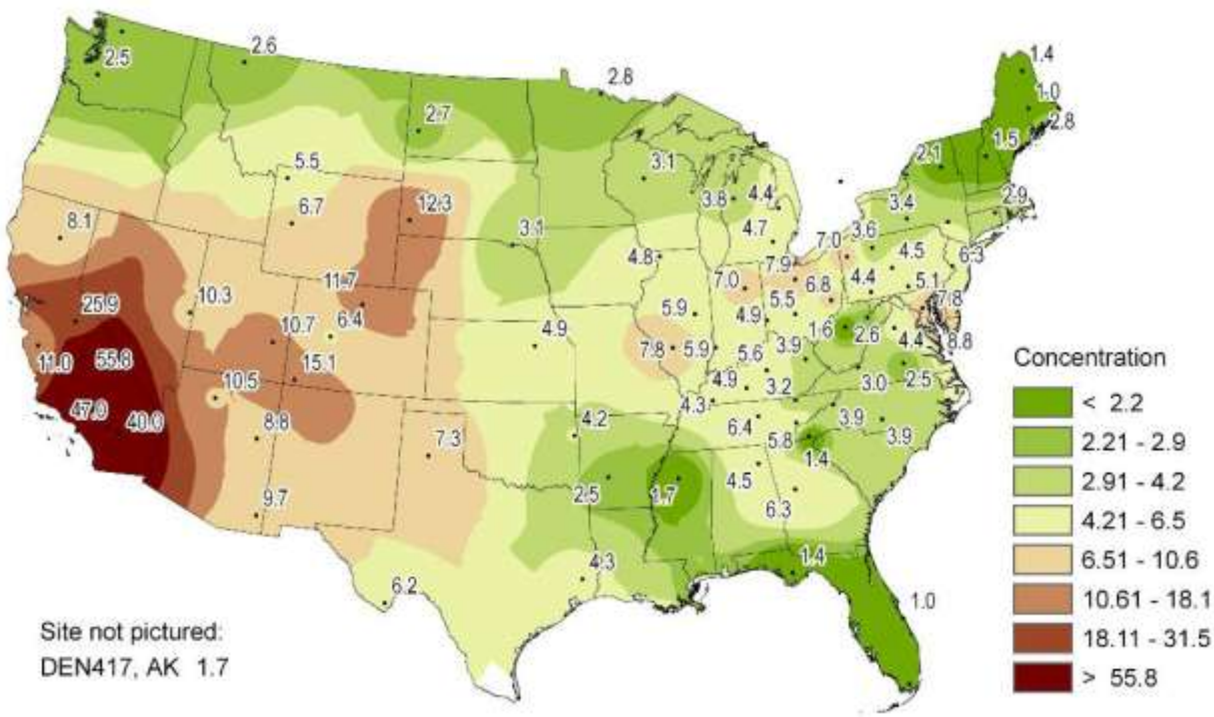
Source: EPA, 2011f

TERRESTRIAL EFFECTS OF OZONE

While other air pollutants may also negatively affect vegetation, ozone is recognized as the one most likely to cause damage. Visible damage to leaf cells may be present in the form of spots or dead areas, though damage can be present long before it becomes visible. Decreased growth or altered carbon allocation may also occur. Ponderosa pine and aspen are species known to be sensitive to ozone in the atmosphere (USFS et. al., 2000).

An index has been developed to express cumulative seasonal impacts to vegetation. This is known as the W126 value. W126 is a cumulative metric that sums weighted hourly ozone concentrations during daylight hours in the summer ozone season. EPA is currently considering a secondary standard for ozone which would be a W126 value of between 7 and 15 ppm-hours. Figure 4 shows national W126 values for 2009 (MACTEC, 2011). This map indicates that much of New Mexico and western portions of Texas, Oklahoma and Kansas would have been in violation of a secondary ozone standard of 7 ppm-hours in 2009, while northwest New Mexico could potentially be in violation of a secondary standard set at a higher level.

Figure 4. W126 values for 2009



Source: MACTEC, 2011

CLIMATE & GREENHOUSE GASES

Climate is the composite of generally prevailing weather conditions of a particular region throughout the year, averaged over a series of years. Climate averages for 1981-2010, known as the current normal as defined by the World Meteorological Organization, are 30 year averages of temperature and precipitation for the previous three decades and are included in Appendix C.

Certain gases cause heat to be retained in the atmosphere. Increases in these gases, known as greenhouse gases (GHGs), are caused by the burning of fossil fuels and are believed to be contributing to global scale impacts to climate (IPCC, 2007a,b). Ongoing scientific research has identified the potential impacts of GHG emissions including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and several trace gases on global climate. Through complex interactions on a global scale, GHG emissions cause a net warming of the atmosphere, primarily by retaining heat energy that would otherwise be radiated by the earth back into space. Although GHG levels have varied for millennia (along with corresponding variations in climate), industrialization and burning of fossil carbon sources have caused GHG concentrations to increase measurably (IPCC, 2007a, b). Changes in climate due to increases in GHGs have the potential to influence renewable and nonrenewable resource management. However, the degree of change and specific effects from these changes cannot be quantified at the regional or local scale at this time (IPCC, 2007a).

The environmental impacts of GHG emissions from oil and gas refining and from consumption, such as from vehicle operations, are not effects of BLM actions related to oil and gas development as defined by the Council on Environmental Quality because they do not occur at the same time and place as the action. Thus, GHG emissions from refining and consumption of oil and gas do not constitute a direct effect that is analyzed under NEPA. Nor are refining and consumption an indirect effect of oil and gas production because production is not a proximate cause of GHG emissions resulting from refining and consumption. However, emissions from refining and consumption and other activities are accounted for in the cumulative effects analysis.

The assessment of GHG emissions and climate change is in its formative phase. It is currently not feasible to know with certainty the net impacts from particular emissions associated with activities on public lands. The inconsistency in results of Global Climate Models used to predict climate change and the lack of models able to predict climate change on regional or local scales, limits the ability to quantify potential future impacts of emissions at this level. When further information on the impacts of local emissions to climate change is known, such information would be incorporated into the BLM's planning and NEPA documents as appropriate.

In New Mexico, a recent study indicated that the increase in mean annual temperatures have exceeded the global average increase by nearly 50% since the 1970's (Enquist and Gori, 2008). Similar to trends in national data, increases in mean winter temperatures in the Southwest have contributed to this rise. When compared to baseline information, periods between 1991 and 2005 show temperature increases in over 95 percent of the geographical area of New Mexico. Warming is greatest in the northwestern, central, and southwestern parts of the state.

METHODOLOGY AND ASSUMPTIONS FOR ANALYSIS OF AIR RESOURCES

Air resource impacts can be analyzed on a number of different levels. First and most basic is to compare monitored pollutant levels with National Ambient Air Quality Standards. This generally applies only to criteria pollutants and provides a basis for determining whether the emissions of any specific pollutant are significant in a local area. Secondly, and necessary before further analysis can be done is an estimate of actual emissions, or an emissions inventory. This may be done for all emissions in a geographic area and for a project to provide a comparison. EPA completes a National Emissions Inventory at the county level every three years which provides a baseline for determining whether project emissions will cause a substantial increase in emissions or materially contribute to potential adverse cumulative air quality impacts. Finally, if impacts are anticipated to be significant, it may be necessary to apply air quality modeling to analyze the extent and geographic distribution of impacts. Further discussion of calculators used for emissions inventory and modeling which may be required for air resource analysis is presented in the following sections. Also, discussed below are methodologies appropriate to GHG analysis which may be very different from those appropriate for air pollutant analysis.

CALCULATORS

Emissions calculators were developed by air quality specialists at the BLM National Operations Center in Denver, Colorado. The calculators use an Excel spreadsheet for computation and are based on emissions factors from EPA and the American Petroleum Institute (API). The calculators were quality assured and improved by the URS Corporation under contract with the BLM. Methodology for computing greenhouse gases is documented in ***The Climate Change Supplementary Information Report for the Montana, North Dakota and South Dakota Bureau of Land Management*** (URS, 2010). Other air pollutant computations have not yet been described in a published document but are based on methods recommended in the EPA publication AP-42 *Compilation of Air Pollutant Emissions Factors* (EPA, 1995, 2006).

The calculators account for a number of variables, including access and construction requirements, equipment and other infrastructure needs, and expected production volumes. Because the algorithms used by the calculators to quantify emissions are based on averages, and because numerous assumptions must be made about construction, the calculators can only provide an educated guess about emissions levels. Actual project emissions may be greater or less than those projected by the calculators.

The BLM in NM has modified the calculators and assumptions for use in analyzing a single well and to more closely represent oil and gas wells in the State of New Mexico; specifically the San Juan and Permian Basins. However, it must be understood that the calculators were originally designed to make estimations of emissions at the RMP level which would result in some averaging and smoothing of assumptions. At the single well level the uncertainty in emissions projections increases substantially.

The BLM has determined that well production typically declines over time and has assumed that declining production would result in reduced emissions over time. A production history may vary from a straight line to a hyperbolic curve. The object of decline curve analysis is to model the production history. Assuming a certain abandonment pressure or gas rate, the decline curve is used to determine the productive life of the well. Well life can vary from a few years to many decades depending on the reservoir and the year it was drilled. Production is also dependent on the price of oil and gas. Since initial development in the San Juan Basin in the 1920s, all reservoirs have had significant reservoir pressure declines. Subsequent infill drilling will encounter reduced pressure reservoirs with limited well life spans compared to wells drilled earlier in the development of the field.

It should be noted that the calculations are based on recently drilled wells and tend to overestimate the average emissions over the lifetime of the well. It is not possible to estimate the lifespan of an individual well, nor is the calculator able to incorporate the decline curve into results, so we have computed one time (construction, completion, workover and reclamation) emissions and annual (operations and maintenance) emissions. However, the annual emissions do not take into account the declining production rates over the lifetime of the well.

ASSUMPTIONS

As mentioned above, the calculators account for a number of variables or inputs that are used to calculate the overall emissions of the different stages of oil and gas development. At the time of an Application for Permit to Drill, not all of these variables may be known. In order to populate the calculators with the different variables, the BLM Carlsbad Field Office (CFO) and the Farmington Field Office (FFO) each developed a set of assumptions pertaining to development in their respective areas. These assumptions address variables such as well depth, production, road development/maintenance, travel to and from well sites, construction times, and need for workovers. The following sections summarize the assumptions made for each field office area in order to populate the calculators.

ASSUMPTIONS - FARMINGTON FIELD OFFICE

There are several geologic formations within the FFO boundary that are known to produce natural gas. The Fruitland is the shallowest routinely produced formation at approximately 2,000 ft. deep. The Dakota is the deepest formation routinely-produced at approximately 6,000 ft. deep. Several formations produce various amounts of water during the production phase of the well. The preferred method of disposing of the produced water is via an injection well drilled into the geologically isolated Entrada formation, which is approximately 7,500 ft. deep. Although wells are not drilled to these precise depths, these generalized depths were used for the purpose of estimation in the emissions calculator.

It is not possible to predict the exact amount of time or equipment required for the development and operation of each gas well in the San Juan Basin. Distinct geologic formations occur at various depths within the San Juan Basin, and individual formations also vary in depth. Even though the exact amount of time required to reach down hole depth is not predictable, a set of assumptions were developed for each formation in order to create an emissions profile for wells drilled in that formation.

BLM specialists and engineers were consulted to develop a range of values to insert into the calculator to estimate the emissions from construction, completion, interim reclamation, annual operation, and final reclamation. Pad construction, interim reclamation, and final reclamation processes are generally the same across the basin. The range of values was designed to address the requirements of about 95% of the wells developed in the San Juan Basin. Unforeseen or unpredictable events may cause approximately 5% of wells to fall outside of the range.

The ancillary activities associated with the production phase of a well such as workovers, road maintenance, and road traffic are difficult to predict. Gas wells in the FFO area do not require workover on a regular schedule. Three to six years between workovers is typical, and the nature of the work required during a workover is variable.

FFO and the oil and gas industry have established a road committee to identify collector roads (main travel corridors) and have established procedures to maintain collector roads as necessary. However, no regular maintenance schedule exists. Most new wells are drilled along existing resource roads that are not covered by the road committee and are maintained as needed. Although road maintenance within the FFO varies, a reasonable assumption is that the resource roads will be maintained once a year. The average length of new road required to drill a new well during the past two years has been 800 ft. Emissions are calculated based on this average assuming that an 800 ft. resource road is maintained once a year and the maintenance work would require about 6 hours of work.

The majority of producing wells in the San Juan Basin utilize remote telemetry powered by solar panels to transmit well production data to centralized office locations. While the frequency of well site visits is not predictable, the need for well site visits during the production phase of the well is greatly reduced by the telemetry systems. Typically, a field technician will drive a light truck and will visit multiple wells per trip along an established service route. To estimate the miles required for each site visit, an additional 4.5 miles of travel along an existing driving route was added to the typical 800 ft. of new road for a total of 5 miles. Emissions are calculated for 100 visits per year for a light truck. For various servicing needs, heavy duty vehicles (over 8,500 lbs. gross vehicle weight rating, as defined by EPA; EPA, 2010g) are required on-site less often than light trucks. Heavy duty vehicles typically do not visit multiple sites per day. Emissions are calculated for driving 50 miles round trip for five trips per year.

The average San Juan Basin gas well in 2009 produced at a rate of 106 mcfd (thousand cubic feet per day). For analysis purposes, the initial production rate is assumed to be 106 mcfd. The volume of gas and oil is normally the greatest following the completion of the well. Oil and gas production rates decline as a function of time, reservoir pressure drop, or the changing relative volumes of the produced fluids.

The FFO RMP (USDI BLM, 2003) addressed air quality based on the Air Quality Modeling Analysis Technical Report prepared by Science Applications International Corporation (SAIC, 2003). The 2003 FFO RMP modeling is considered here because it was used to characterize air quality for the purpose of land use planning, and this environmental assessment tiers to the 2003 FFO RMP. The 2003 SAIC modeling was based on the highest level of oil and gas development proposed based on the RFD and identified a potential for exceeding the NAAQS for NO_2. The alternative selected for the RMP proposed a lower level of development than that modeled. Lower levels of development and NO_x limits placed on engines have resulted in lower emissions than were modeled.

ASSUMPTIONS – CARLSBAD FIELD OFFICE

The CFO area of responsibility contains 28 different geologic zones that produce oil, natural gas and water. The complex geology, variety of drilling techniques used (horizontal, vertical), uncertainty of production, and variation of the drilling time and equipment required makes it difficult to approximate the emissions for a proposed well. In order to provide a basis for extrapolation, the CFO selected a random sample of seventy wells out of a population of 1836 wells drilled within the last 4 years (2007-2010). These recently drilled wells were selected to incorporate the latest technology, the latest trends in oil and gas development, and the most recent production data. This sample of newer wells will over estimate average annual production (and therefore emissions) as production drops with the age of the well. The sample size was selected to insure that it was representative of 95% of the recently drilled wells.

The 70 wells were reviewed to ensure accurate production data was available and to eliminate older wells that had been re-drilled into a new formation. Sixty-eight wells remained after the review. This was still a sufficient sample size to ensure statistical accuracy, so no additional wells were selected. The annual production values for oil, gas, and water, length of road constructed, well pad size and travel distances to reach the well from the nearest town were calculated for each well. The lowest, highest, and mean values were then calculated for each parameter and used to create three emissions scenarios (maximum, minimum, and average). These values represent the maximum, minimum and average emissions for 95% of the new wells in the CFO. Unforeseen or unpredictable events may cause 5% of wells to fall outside of the range. Because the minimum scenario has no production, it can be used to estimate the emissions from a salt-water disposal well.

Other values required for the calculator were conservatively estimated by BLM resource staff. It is not possible to predict the exact amount of time or equipment required for the development and operation of a well in the Permian Basin due to the varied geological formations, numerous operators and other variables. Therefore, BLM specialists and engineers were consulted to develop a range of values to insert into the calculator to estimate the emissions from construction, completion, interim reclamation, annual operation, and final reclamation. The range was designed to include the requirements of 95% of the wells that may be developed in the Permian Basin. Where no information was available the default values from the calculator were used. The calculator will be updated as additional information becomes available.

The ancillary activities associated with the production phase of a well such as workovers, road maintenance, and road traffic are difficult to predict. Oil and gas wells in the CFO do not require workover on a regular basis and when these activities occur, they generally are not reported to the BLM. Three to six years between workovers is routine, and the nature of the work required during a workover is variable. It is assumed that any gas released during the completion process will be flared. The calculator assumes 100 percent combustion efficiency.

The emissions calculator can be used to estimate PM as a result of construction and drilling activities related to pad building and road traffic. The amount of PM emissions depends on the length, surface condition; soil types traversed, and soil moisture conditions of the road to the site. Because site visit frequencies vary and are difficult to predict, varying numbers of site visits were input into the calculator, which had almost no impact on the total tons of PM emitted. Most gas wells in the Permian Basin utilize remote telemetry powered by solar panels to transmit well production data to centralized office locations. The need for well site visits during the production phase at these wells is greatly reduced. Oil wells require site visits, and the frequency of well visits is not predictable.

While the frequency of well site visits is not predictable, the need for well site visits during the production phase of the well is greatly reduced by the telemetry systems. Typically, a field technician will drive a light truck and will visit multiple wells per trip along an established service route. It was estimated that an average trip distance consists of two miles 3 times per week. This information is used in calculating the annual operation emissions. Heavy trucks are required on site less often than light trucks for various servicing needs. Heavy trucks typically do not visit multiple sites per day. Distances to the wells were determined from the statistical sample including the total distances traveled on dirt and paved roads to reach the well from the nearest town (Carlsbad, Artesia, Hobbs, etc). Emissions include maintenance and inspection of the well. Reclamation of the well site and road will be conducted when the well has finished producing and is plugged and abandoned. Emissions from reclamation of the well pad and road are also estimated.

County roads in the CFO have established procedures for maintenance but no regular maintenance schedule exists. Most new wells are drilled along oil and gas lease roads that are only maintained by oil and gas operators as needed. Therefore, road maintenance within the CFO is not predictable. The average length of new road required to drill a new well during the past four years based on the random sample has been 570 ft. Emissions are calculated based on this average assuming that a 570 ft. resource road is maintained once a year.

Maximum, minimum and average emissions for construction, completion/recompletion, workover, annual operations, annual road maintenance, and reclamation have been calculated and are presented in project APD EAs. Note that these estimates are based on hypothetical scenarios and it is unlikely that the maximum emissions scenario would ever occur.

AIR QUALITY MODELING

The calculators may be considered a type of model in that they use emissions factors, mathematical algorithms, and assumptions to arrive at some approximation of reality. However, their primary purpose is to compute an emissions inventory which is a necessary ingredient to any modeling effort.

Traditional air quality modeling generally falls into three categories. 1) Near-field dispersion modeling is applied to criteria pollutants, HAPs and AQRVs where a small to medium number of sources are involved to cover an area within 50km of a proposed project. 2) Far-field or transport modeling is used to provide regional assessments of cumulative and incremental impacts at distances greater than 50km. 3) Photochemical modeling is necessary for large scale projects with a large number of sources or with complex issues including ozone and secondary particulate impacts. An Air Quality Memorandum of Understanding (MOU) recently signed by the Department of Agriculture, Department of the Interior, and Environmental Protection Agency contains an Appendix which describes the air quality models available and their advantages, disadvantages and applications. The MOU and Appendix are included as Appendix E of this document.

METHODOLOGY FOR ANALYSIS OF GHGS

Air quality models which predict concentrations and transport of pollutants are not applicable to greenhouse gases which impact the atmosphere at a global scale. The science does not currently support attempts to relate local emissions of greenhouse gases to local or regional impacts. The greenhouse gas emissions information derived from the calculators is useful in comparing project level emissions with nationwide and global emissions to provide a perspective on the relative contribution to potential changes in climate.

Carbon dioxide is generated by the combustion of fossil fuels used to power the various engines required for the drilling and production of natural gas. Estimated emissions for CO_2 are obtained from the calculator for the drilling and operational phases of the well, as well as for other ancillary aspects of well development. These values include emissions from combustion engines used to construct and maintain the well.

Methane releases from gas well development result from venting of natural gas during the well completion process, actuation of gas operated valves during well operations, and fugitive gas leaks along the infrastructure required for the production and transmission of gas. Estimated emissions for CH_4 are obtained from the calculator. These values include emissions from combustion engines used to construct and maintain the well. No methane emissions are predicted from ancillary construction operations.

Greenhouse gases are included in the emissions calculator and predictable greenhouse gas emissions are reported. The predicted greenhouse gas emissions are compared to the baseline statewide greenhouse gas emissions as reported in the Inventory of New Mexico Greenhouse Gas Emissions: 2000-2007 (NMED, 2010).

BLM has also used a top down approach to estimate greenhouse gas emissions based on EPA's national Greenhouse Gas Emissions Inventory (EPA, 2011e) and local oil and gas production as a percentage of U.S. production. This approach does not account for emissions from fossil fuel combustion but does provide a level of comparison for GHGs associated with oil and gas production managed by BLM to U.S. emissions from all oil and gas production and with total national emissions.

CUMULATIVE EFFECTS

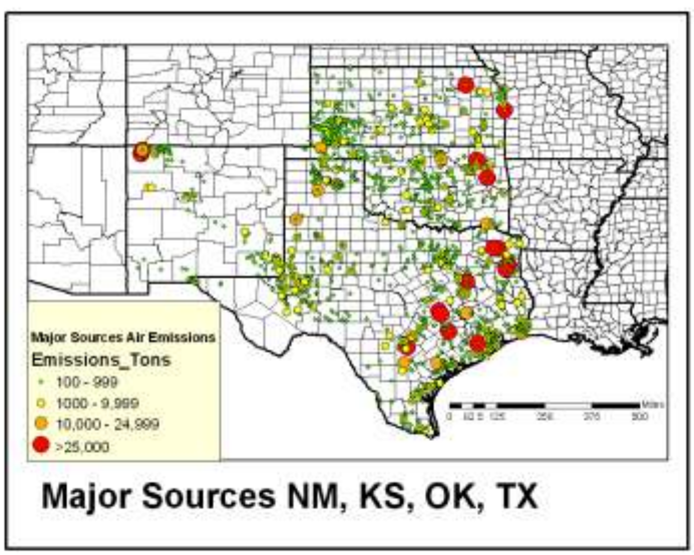
The CEQ regulations define cumulative effects as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions” (40 CFR 1508.7; BLM, 2008).

Existing conditions of air resources in any given location are the result of numerous complex factors, both natural and human caused. Natural factors contributing to the current condition of air resources include existing climate resulting from long-term atmospheric weather patterns, soil types, and vegetation types. Anthropogenic factors contributing to the current condition of air resources include long-term human habitation, growing human populations, transportation methods and patterns, recreational activities, economic patterns, the presence of power plants and other industrial sources. The presence of natural resource (i.e. oil and natural gas) extraction and processing on some BLM lands also impact air quality and greenhouse gas emissions.

CURRENT AND FORESEEABLE CONTRIBUTIONS TO CUMULATIVE EFFECTS

A list of major sources (emitting >100 tons/year of any pollutant) in New Mexico, Kansas, Oklahoma, and Texas can be found in Appendix D. Any of these sources may contribute to cumulative effects within a local or regional context. More specific information about sources in New Mexico’s oil and gas producing regions which have the greatest impacts on air quality and greenhouse gases is included below. Figure 5 shows a map of major sources in the four state area. Similar maps for the individual states are included in Appendix D.

Figure 5. Major Emissions Sources New Mexico, Kansas, Oklahoma and Texas



ELECTRICAL GENERATING UNITS

There are two coal-fired electrical generation units (EGUs) in the Four Corners area: the San Juan Generating Station, located 15 miles west of Farmington, NM; and the Four Corners Power Plant, located on Navajo Nation land in Fruitland, NM. These EGUs are the primary source of several criteria air pollutants in the FFO area, including SO_2 (95.5%), NO_x (70.7%), and $PM_{2.5}$ (19.2% (EPA, 2010d). EGUs are responsible for 31% of New Mexico GHG emissions (NMED, 2010c) and 32% of U.S. GHG emissions (EPA, 2011e). These power plants are expected to continue operations for the foreseeable future. However, EPA has recently announced proposals to reduce emissions at both plants under the Best Available Retrofit Technology provision of the Regional Haze Rule.

A proposed Federal Implementation Plan (FIP) for the San Juan Generating Station (SJGS) was published on January 2011(FR, 2011a). If enacted, NO_x emissions for SJGS would be reduced by 83 percent. A FIP was proposed for the Four Corners Power Plant on October 19, 2010 (FR, 2010) and amended on February 25, 2011 (FR, 2011b). The original proposal would result in an 80% NO_x emissions reduction, while the amended plan would reduce NO_x by 87%. These potential emissions reductions could result in significant improvements to air quality in the Four Corners area beginning in 2014.

FOSSIL FUEL PRODUCTION

Fossil fuel production contributes to air pollutants and GHG emissions in the Farmington and Carlsbad Field Office areas, especially San Juan, Northwestern Sandoval, Eddy, Lea, and Chaves counties as well as in parts of Oklahoma, Kansas and Texas. This includes oil and gas production, natural gas compressor stations and pipelines, gas plants, and petroleum refining. Coal mining is also occurring in the FFO and Oklahoma Field Office (OFO) areas. Potash mining in the CFO area also contributes to air contaminants and GHGs.

The BLM has jurisdiction over federal oil and gas exploration and production on Federal and Indian mineral estate. Once produced oil or gas leaves the well location (via pipeline or tanker truck), the BLM no longer has jurisdiction over these products.

There are currently approximately 16,435 oil and gas wells on federal mineral estate in the counties within FFO (San Juan, Rio Arriba, Sandoval, and McKinley) that are categorized as active, new or temporarily abandoned (ONGARD data, NMOCD, 2010). If oil and gas wells with private (fee), state-owned, or Indian mineral estate in these counties are included, there is a total of 23,522 active, producing, and inactive (shut in or temporarily abandoned) wells in the area. Table 5 shows 2009 oil and gas production on federal leases by state and as a percentage of U.S. production.

In 2008, there were approximately 16,060 oil and gas wells on federal mineral estate in the counties within CFO (Eddy, Lea and Chavez) that are categorized as active, new or temporarily abandoned (ONGARD data, NMOCD, 2010; Table 2). If oil and gas wells with private (fee), state-owned, or Indian mineral estate in these counties are included, there are approximately 25,000 active, producing, and inactive (shut in or temporarily abandoned) wells in the area.

Table 5: 2009 Oil and Gas Production

Location	Oil (bbl)	% U.S. Total	Gas (MMcf)	% U.S. Total
United States	1,751,000,000	100	21,604,158	100
New Mexico	61,400,044	3.51	1,508,840	6.98
Federal leases NM	28,184,393	1.61	882,042	4.08
San Juan Basin	1,593,795	0.09	681,648	3.16
Permian Basin	26,590,598	1.52	198,062	0.92
Kansas	39,464,000	2.25	355,394	1.65
Federal leases KS	251,690	0.01	6,306	0.03
Oklahoma	67,018,000	3.83	1,857,777	8.60
Federal leases OK	235,511	0.01	11,214	0.05
Texas (onshore)	403,797,000	23.06	7,615,836	35.25
Federal leases TX	358,688	0.02	34,818	0.16

Table 6 shows the estimated GHG emissions for oil and gas field production for the U.S., New Mexico, Kanasas, Oklahoma and Texas and for Federal leases in those states including New Mexico portions of the San Juan and Permian Basins. Because oil and gas leaves the custody and jurisdiction of the BLM after the production phase and before processing or refining, only emissions from the production phases are considered here. It should also be remembered that following EPA protocols, these numbers do not include fossil fuel combustion, which would include such things as truck traffic, pumping jack engines, compressor engines and drill rig engines. Nor does it include emissions from power plants that generate the electricity used at well sites and facilities. Note that units of metric tons CO_2e have been used in Table 2 to avoid very small numbers. (For comparison one million metric tons is equal to one teragram [Tg]).

Table 6 provides an estimate of direct emissions that occur during exploration and production of oil and gas. This phase of emissions represents a small fraction of overall emissions of CO_2e from the life cycle of oil and gas. For example, acquisition (drilling and development) for petroleum is responsible for only 8% of the total CO_2e emissions, whereas transportation of the petroleum to refineries represents about 10% of the emissions, and final consumption as a transportation fuel represents fully 80% of emissions (U.S.DOE, NETL, 2008).

Table 6 also shows that the total emissions from oil and gas production on Federal leases in the San Juan Basin in 2009 were estimated at 647,684 metric tons CO_2e. Emissions from federal leases in the Permian Basin were estimated to be 569,573 metric tons CO_2e. Note that this represents non-combustion emissions only.

Table 6: 2009 Oil and Gas Field Production Emissions (metric tons CO_2e)

Location	Oil (Metric Tons CO_2e)		Gas (Metric Tons CO_2e)		Total O&G Production (Metric Tons CO_2e)	%U.S. Total GHG Emissions
	CO_2	CH_4	CO_2	CH_4		
United States	500,000	28,400,000	8,500,000	14,100,000	51,500,000	0.74
New Mexico	16,607	943,287	486,196	806,513	2,252,603	0.03
Federal Leases NM	7,092	402,844	303,638	503,682	1,217,257	0.02
San Juan Basin	442	25,080	233,999	388,164	647,684	0.01
Permian Basin	6,651	377,765	69,639	115,518	569,573	0.01
Kansas	6,761	682,901	179,308	2,143,469	3,012,439	0.045
Federal Leases KS	43	4,355	3,182	38,035	45,615	0.001
Oklahoma	11,482	1,159,706	937,309	11,204,711	13,313,208	0.201
Federal Leases OK	40	4,075	5,658	67,633	77,406	0.001
Texas	69,183	6,987,464	3,842,437	45,932,983	56,832,067	0.857
Federal Leases TX	61	6,207	17,567	209,998	233,833	0.004

The New Mexico Greenhouse Gas Inventory and Reference Case Projection 1990-2020 (NMED, 2010c) estimates that approximately 17.3 million metric tons of GHGs from the natural gas industry and 2.3 million metric tons of GHGs from the oil industry were projected in 2010 as a result of oil and natural gas production, processing, transmission and distribution. As of 2008, there were 23,196 oil wells and 27, 778 gas wells in New Mexico (NMOCD, 2010).

Compressor engines link the natural gas pipeline infrastructure that transports natural gas from its source to points of consumption. There are approximately 4,000 well head compressors run by engines under 300 horsepower (hp) and 209 central natural gas compressor stations over 300 hp permitted by NMED. These pipelines and compressor stations produce fugitive gas emissions. Emissions from these sources in 2009 are quantified in the U.S. EPA Inventory of Greenhouse Gas Emissions and Sinks (EPA, 2011c) at the national level as the “processing, transmission and storage, and distribution” subsectors of the Natural Gas Systems sector. These three subsectors emitted 112.2 million metric tons of GHGs in 2009, which was 1.69% of total U.S. GHG emissions in 2009.

EPA Natural Gas Star partner companies operate 78% of the active federal wells in the New Mexico portion of the San Juan Basin. EPA has found Natural Gas Star partners' actions to result in measurable decreases in GHG emissions since the program's implementation.

Crude oil produced throughout New Mexico is transported by pipeline and/or tanker truck to refineries where the oil is processed into various types of fuel. There are two refineries in the CFO, both operated by the Navajo Refining Company; one in Artesia and one in Lovington. There are currently no refineries operating in the FFO area. Transportation and processing of crude oil and petroleum products result in emissions of various hazardous air pollutants, criteria pollutants, and GHGs. In 2009, crude oil transportation and refining in the U.S. accounted for 0.8 metric tons CO_2e emitted (EPA, 2011e), which is 0.01% of the U.S. total GHG emissions.

Potash mining is another major industry in the CFO area. There are two mining companies operating 4 potash processing plants in the CFO area. Potash production produces emissions of various hazardous air pollutants and criteria pollutants. Potash mining produces an insignificant percentage of total US GHG emissions (EPA, 2011e).

Coal mining is another major industry in San Juan County. BHP Billiton operates two coal mines in the area that provide coal to the San Juan Generating Station and the Four Corners Power Plant. Coal production produces emissions of various hazardous air pollutants, criteria pollutants, and CH_4. In 2009, coal mining in the U.S. contributed 71 million metric tons CO_2e, which is 10.3% of total U.S. CH_4 emissions, and 1.3% of total U.S. GHG emissions (EPA, 2011e).

TRANSPORTATION

Another primary source of emissions that impact air quality is vehicular travel. The number of vehicles, miles traveled, types of vehicles in use, and the condition of road surfacing, all factor into the emissions from vehicular travel. On and off-road vehicles produce exhaust which contains NOx and VOCs as well as Carbon Monoxide and Particulate Matter.

In 2009, fossil fuel combustion associated with transportation contributed 1,718.9 million metric tons CO_2e to total U.S. GHG emissions, which accounted for 25.9% of U.S. GHG emissions that year (EPA, 2011c). Although it is expected that vehicle fuel efficiency and increased use of public transportation will reduce vehicle emissions, these reductions may eventually be offset by an increased number of vehicles in use due to population growth in the region.

CLIMATE CHANGE

The 2007 Intergovernmental Panel on Climate Change *Summary for Policy Makers* (IPCC, 2007b) stated that "Global atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed preindustrial values determined from ice cores spanning many thousands of years."

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 (Goddard Institute for Space Studies, 2007). However, observations and predictive models indicate that average temperature changes are likely to be greater in the Northern Hemisphere (IPCC, 2007a, b). Without additional meteorological monitoring and modeling systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions. What is known is that increasing concentrations of GHGs may accelerate the rate of climate change (IPCC, 2007a, b).

In 2007, the IPCC predicted a global average warming of about 0.2°C per decade for the next two decades, and then a further warming of about 0.1°C per decade. The National Academy of Sciences (2006) supports these predictions, but has acknowledged that there are uncertainties regarding how climate change may affect different regions. Computer model predictions indicate that increases in temperature will not be equally distributed, but are likely to be accentuated at higher latitudes (IPCC, 2007a). Warming during the winter months is expected to be greater than during the summer, and increases in daily minimum temperatures are more likely than increases in daily maximum temperatures.

Currently, global climate models are unable to forecast local or regional effects on resources (IPCC, 2007a; CCSP, 2008). However, there are general projections regarding potential impacts to natural resources and plant and animal species that may be attributed to climate change from GHG emissions over time; however these effects are likely to be varied, including those in the southwestern United States (Karl et al., 2009). For example, if global climate change results in a warmer and drier climate, increased particulate matter impacts could occur due to increased windblown dust from drier and less stable soils. Cool season plant species' spatial ranges are predicted to move north and to higher elevations, and extinction of endemic threatened or endangered plants may be accelerated. Due to loss of habitat or competition from other species whose ranges may shift northward, the populations of some animal species may be reduced or increased. Less snow at lower elevations would likely impact the timing and quantity of snowmelt, which, in turn, could impact water resources and species dependent on historic water conditions (Karl et al., 2009).

Climate change is a global process that is impacted by the sum total of GHGs in the Earth's atmosphere. The incremental contribution to global GHGs from the proposed action cannot be translated into effects on climate change globally or in the area of any site-specific action. It is currently not feasible to predict with certainty the net impacts from a proposed action on global or regional climate. That is, while BLM actions may contribute to climate change, the specific effects of those actions on global or regional climate are not quantifiable. Therefore, the BLM does not have the ability to associate an action's contribution in a localized area to impacts on global climate change. As climate models improve in their sensitivity and predictive capacity, the BLM will incorporate those tools into NEPA analysis at that time.

GLOBAL, NATIONAL AND STATE GHG EMISSIONS

A 2005 report from the World Resources Institute entitled ***Navigating the Numbers*** summarizes global greenhouse gas emissions by country and by sector in the early 2000's. In 2000 the United States led the world with about 20% of global emissions (Baumert, et. al., 2005). The United Nations reports that China overtook the U.S. in 2005 as the world's leading producer of carbon dioxide (UN, 2011). Flowcharts of GHG emissions for the World and the U.S. produced by the WRI indicate that oil and gas extraction, refining and processing accounted for 6.3% of emission globally in 2000 but only 3.0% of U.S. emissions in 2003 (WRI, 2010).

The EPA's Inventory of US Greenhouse Gas Emissions and Sinks found that in 2009, total U.S. GHG emissions were almost 7 billion (6,639.7 million) metric tons and that total U.S. GHG emissions have increased by 7.4% from 1990 to 2009 (EPA, 2011e). Emissions declined from 2008 to 2009 by 6.0% (422.2 million metric tons Carbon Dioxide equivalent(CO_2e). The primary causes of this decrease were the reduced energy consumption during the economic downturn and increased use of natural gas relative to coal for electricity generation (EPA, 2011e).

The Inventory of New Mexico Greenhouse Gas Emissions: 2000-2007 (NMED, 2010) lists total statewide gross GHG emissions in 2007 as 76.2 million metric tons CO_2e, which is a slight reduction from the estimate in 2000 of 77.0 million metric tons CO_2e. The primary contributors to 2007 GHG emissions in New Mexico were electricity production (42%), the fossil fuel industry (22%), and transportation (20%; NMED, 2010).

According to the New Mexico Greenhouse Gas Inventory and Reference Case Projections, 1990-2020, GHG emissions are expected to continue increasing (NMED, 2006). With respect to GHGs emitted by oil and gas development, CO_2 is produced during the burning of fossil fuels to run internal combustion engines which may be used in drilling, transportation, pumping and compression. CO_2 may be a significant component of natural gas, especially coalbed methane, and is vented during field operations or processing. CO_2 is also used in enhanced oil production processes and may be released or escape to the atmosphere during those processes.

Methane is the primary component of natural gas and is released to the atmosphere during both oil and gas production either intentionally during production when it cannot be captured, or accidentally through leaks and fugitive emissions.

The EPA's GHG inventory data describes "Natural Gas Systems" and "Petroleum Systems" as two of the major categories of US sources of GHG gas emissions. The inventory identifies the contributions of natural gas and petroleum systems to total CO_2 and CH_4 emissions (natural gas and petroleum systems do not produce noteworthy amounts of any of the other greenhouse gases; Table 7). Within the larger category of "Natural Gas Systems", the EPA identifies emissions occurring during distinct stages of operation, including field production, processing, transmission and storage, and distribution.

Table 7. U.S. Inventory of Greenhouse Gas Emissions for oil and gas subsectors 2009

		2009 GHG Emissions ($TgCO_2e$)				% of U.S. Total GHGs
Sector	**Subsector**	CO2	CH4	N_20	Total GHGs	
Natural Gas Systems	Total	32.2	221.2	*	253.4	3.82%
	Field production	10.9	130.3	*	141.2	2.13%
	Processing	21.2	17.5	*	38.7	0.58%
	Transmission and storage	0.1	44.4	*	44.5	0.67%
	Distribution	*	29	*	29	0.44%
Petroleum Systems	Total	0.5	30.9	*	31.4	0.47%
	Production field operations	0.3	30.3	*	30.6	0.46%
	Crude oil transportation	0.0	0.1	*	0.4	0.01%
	Crude refining	0.1	0.5	*	0.6	0.01%
Fossil Fuel Combustion	Total	5,212.0	9.0	50.0	5,270.9	79.4%
	Electricity generation	2,154.0	1.3	18.4	2,173.7	32.7%
	Transportation	1,718.9	2.2	27.8	1,748.9	26.3%
Coal Mining	--	*	71.0	*	71.0	1.3%
U.S. Total		5,508.1	686.5	299.5	6,639.7**	100.00%
*Indicates values that do not exceed 0.05 TgCO2e						
**Indicates that the total U.S. GHG emissions value includes U.S. emissions of three additional minor classes of GHGs.						

(EPA, 2011e). CO_2 emissions listed for sectors other than "Fossil Fuel Combustion" represent non-combustion CO_2 emissions. In the Fossil Fuel Combustion sector category, data for only two subsectors are listed here. The natural gas and petroleum subsectors that BLM regulates for on-shore operations on federal mineral estate are highlighted in gray.

"Petroleum Systems" sub-activities include production field operations, crude oil transportation and crude oil refining. Within the two categories, the BLM has authority to regulate those field production operations that are related to oil and gas measurement and prevention of waste (via leaks, spills and unauthorized flaring and venting).

The EPA reports that national emissions from Natural Gas Systems in 2009 increased by 17% for methane but decreased 14% for non-combustion CO_2 relative to 1990 levels. The decrease is attributed to improved management practices and technology and replacement of older equipment. Increasing emissions reduction through participation in EPA's Natural Gas Star Program, which provides strategies for voluntary emissions reductions, is thought to have contributed to recent decreases in methane emissions as well. For Petroleum Systems, methane emissions have declined by 13% and non-combustion CO_2 emissions declined by 17% since 1990, due primarily to industry efforts to reduce emissions and declines in domestic oil production (EPA, 2011e).

POTENTIAL MITIGATION STRATEGIES

The reduction of emissions of air pollutants and greenhouse gases from oil and gas operations has been the subject of much study and discussion in recent years. The EPA Natural Gas Star Program established in 1993 has been a leader in developing and reporting on strategies to reduce methane emissions (EPA, 2011g). These reductions can help to control not only greenhouse gases but VOCs which contribute to ozone formation. Many of the operators in the San Juan and Permian Basins are already members of this voluntary program. A recent survey showed that 8 companies operating in the San Juan Basin, responsible for 78% of federal wells were Natural Gas Star Partners. In the Permian Basin at least 19 companies operating in New Mexico are known to be Natural Gas Star Partners. Numerous opportunities for emissions reduction, including costs to implement, are documented on EPA's the Natural Gas Star website (EPA, 2011g).

A recent report by the Government Accountability Office (GAO) noted that opportunities exist for capturing fugitive emissions from venting and flaring of natural gas on wells under federal jurisdiction (USGAO, 2010). A report prepared for BLM in Montana includes an entire chapter on reduction of emissions of greenhouse gases (URS, 2010). Another report recently issued by the U.S. Forest Service summarizes and builds on work originally done by BLM to identify Best Management Practices for protection of air quality during oil and gas development and production (USFS, 2011).

While it is beyond the scope of this report to detail the wide range of mitigation strategies available it must be understood that for the most part these strategies must be applied on a case by case basis at the project level. Some broader range strategies applied within the BLM New Mexico State Office jurisdiction are discussed below.

FOUR CORNERS AIR QUALITY TASK FORCE

In 2002, the State of New Mexico Environment Department convened the Four Corners Ozone Task Force, composed of a wide range of interested stakeholders, to evaluate an Early Action Compact (EAC) for ozone. In 2005, the states of Colorado and New Mexico charged the group, then known as the Four Corners Air Quality Task Force (Task Force), with addressing air quality issues in the Four Corners region and considering options for mitigating air pollution. A report detailing a wide range of mitigation options was published in November 2007 (FCAQTF, 2007).

In 2008, its task complete, the group became known as the Four Corners Air Quality Group (FCAQG) and continued on as a forum for discussion of existing air quality issues and potential solutions. The FCAQG is currently comprised of more than 100 members and 150 interested parties representing a wide range of perspectives on air quality in the Four Corners region. Members include private citizens, representatives from public interest groups, universities, industry, state, tribal and local governments, and federal agencies. The BLM has been an active participant from the beginning and maintains a representative on the steering committee.

IR CAMERAS

The BLM recently purchased two Infrared Cameras which are being used to detect leaks and fugitive emissions. BLM inspectors carry these cameras into the field and have been able to alert operators of equipment requiring repair or maintenance. At this time the cameras are being used in an advisory rather than a regulatory role.

KANSAS, OKLAHOMA AND TEXAS

While BLM does not manage any lands directly in these states the agency does have jurisdiction over mineral rights on federal lands managed by other agencies and on split estate lands in Kansas and Oklahoma. A review of Table 6 above will show that oil and gas production on federal leases is fairly small compared to production on other lands in these states. The purpose of this chapter is to address air quality concerns and regulations that are unique to these states and not already covered above.

KANSAS

The regulatory authority for air quality in Kansas is the Kansas Department of Health and Environment, Bureau of Air (http://www.kdheks.gov/bar/). The state does not have any ambient air quality standards that differ from the NAAQS (Table 1). There are currently no non-attainment areas for any criteria pollutant in the state of Kansas. However, several counties in the Kansas City area were recommended for non-attainment status under the 2008 ozone standard. Under EPA's proposed new standard for ozone several additional counties including some in the Wichita area could violate the standard.

OKLAHOMA

The regulatory authority for air quality in Oklahoma is the Oklahoma Department of Environmental Quality, Air Quality Division (http://www.deq.state.ok.us/AQDnew/). Oklahoma's ambient air quality standards are identical with the NAAQS (Table 1). There are currently no nonattainment areas in the state of Oklahoma. However, several counties are expected to fall into non-attainment status based on the revision to the ozone standard proposed by EPA.

TEXAS

The regulatory authority for air quality in Texas is the Texas Commission on Environmental Quality(TCEQ), Air Division. The state does not have any ambient air quality standards that differ from the NAAQS (Table 1).

NON-ATTAINMENT AREAS AND CONFORMITY ANALYSIS

There are currently three non-attainment areas in Texas, one for PM_{10} (El Paso) and two for ozone (Houston area, Dallas-Fort Worth area). EPA's conformity rule requires that all federal actions in a non-attainment area must demonstrate conformity with the State Implementation Plan (SIP) for the pollutant in question. If the agency can demonstrate that emissions for the action will fall below certain established levels, known as de minimus, then no further analysis is necessary. In order to establish de minimus an emissions inventory for the project is required. In the case of ozone the emissions inventory would include NOx and VOCs. If emissions are projected to be above de minimus levels further analysis should be coordinated with the EPA and Texas CEQ.

The Houston-Galveston-Brazoria area was designated as severe nonattainment for 8 hour ozone based on the 1997 standard in October 2008 and includes the following counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller. De minimis values for both NOx and VOC in this area are 25 tons/year.

The Dallas-Fort Worth ozone nonattainment area was designated in June 2004, is classified as moderate and includes the following counties: Collin, Dallas, Denton, Tarrant, Ellis, Johnson, Kaufman, Parker, and Rockwall. De minimis values in this area are 100 tons/yr for NOx and 50 tons/yr for VOC.

AIR QUALITY MODELING FOR TEXAS

Numerous reports on air quality modeling projects done by and for the TCEQ, including modeling done for the Dallas and Houston non-attainment areas can be accessed on the Air Division website (http://www.tceq.texas.gov/airquality/airmod/am). It is beyond the scope of this report to try and summarize the results of these studies.

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